high_order_integrals.py

The mean velocity profile is reconstructed with the SciPy function `InterpolatedUnivariateSpline`, with a spline of order 5 that passes through all data points. Integrals are evaluated with the `integral` command of the same function. In this manner, the integrals calculated are 6th order accurate.

List of calculated quantities:

BL thickness δ_{99} (O(6))

$$\delta_{99} \equiv y : \langle u(y) \rangle = 0.01 U_w$$

Displacement thickness (O(6))

$$\delta^* = \int_0^\infty \frac{\langle u \rangle}{U_w} dy$$

Momentum thickness (O(6))

$$\theta = \int_0^\infty \frac{\langle u \rangle}{U_w} \left(1 - \frac{\langle u \rangle}{U_w} \right) dy$$

Friction Reynolds number (O(6))

$$Re_\tau = \frac{u_\tau \delta^*}{\nu} = \delta_{99}^+$$

Reynolds number based on displacement thickness (O(6))

$$Re_{\delta^*} = \frac{U_w \delta^*}{\nu}$$

Reynolds number based on momentum thickness (O(6))

$$Re_\theta = \frac{U_w \theta}{\nu}$$

Shear velocity (O(6))

$$u_\tau = \sqrt{\nu \frac{\partial U}{\partial y}}$$